THE CAROLINA ENGINEER

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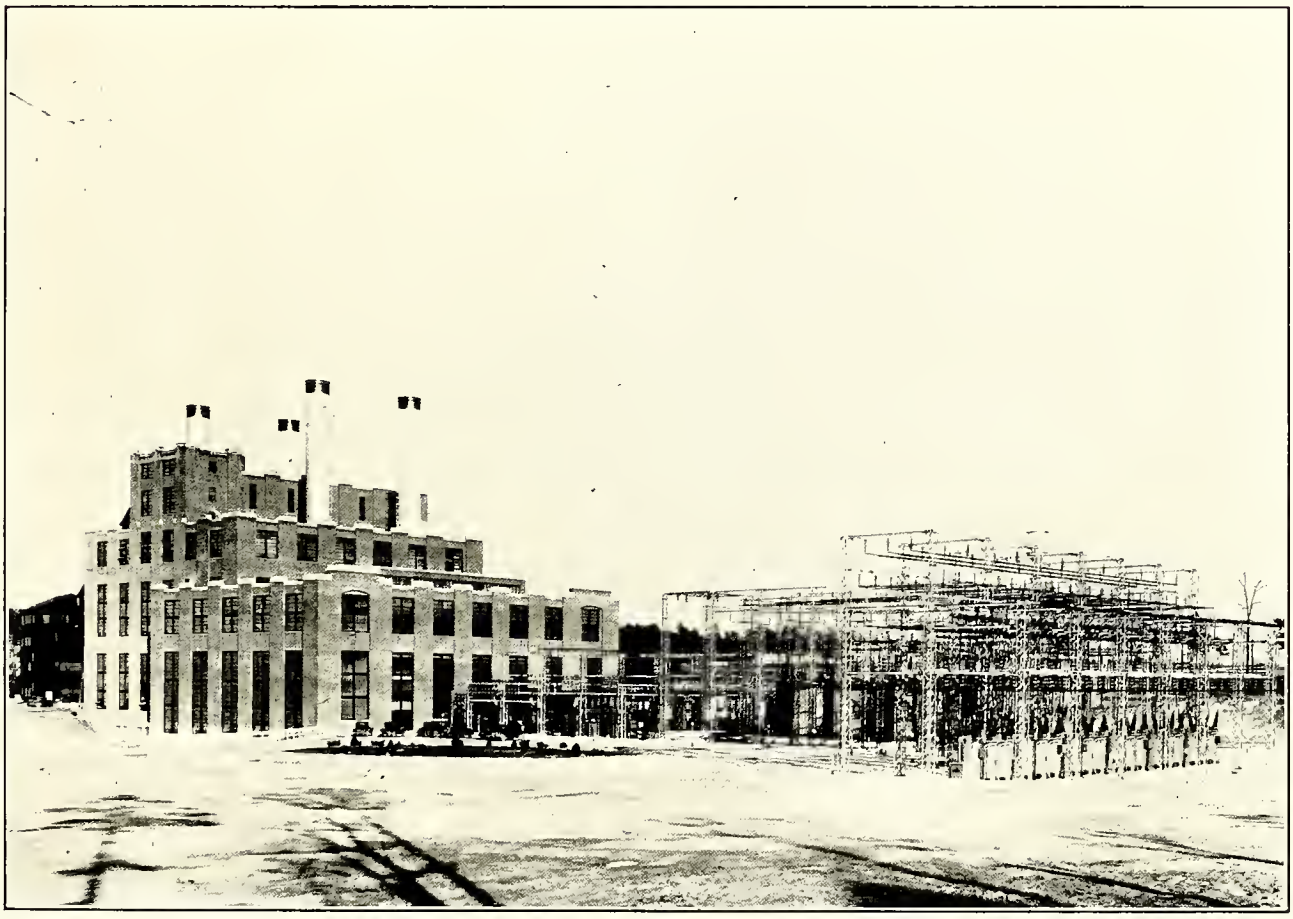
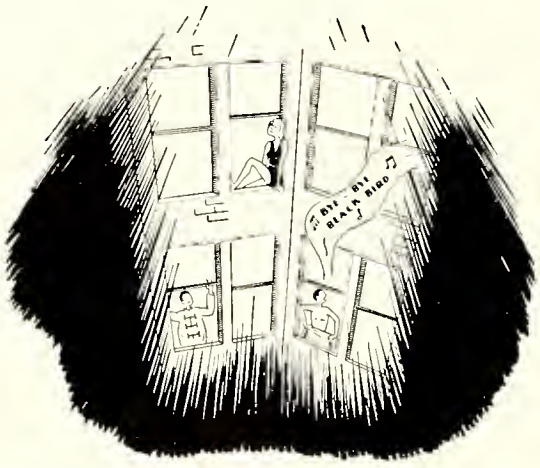


RIVERBEND POWER PLANT

Volume 3 ~ *Number 4*

MAY, 1935

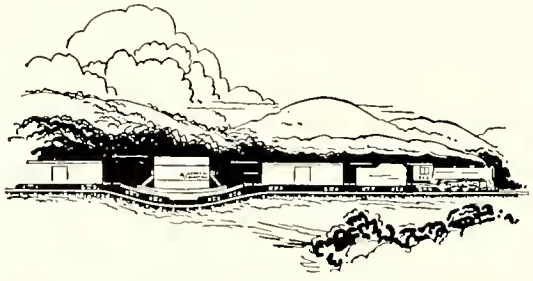
G-E *Campus News*



SYNTHETIC SUNLIGHT

THE people whose apartments faced the lower levels of the ventilating shafts in a 14-story New York apartment house had long ago given up the hope that direct sunlight would enter their windows. Imagine their astonishment one morning not long ago to find light—lots of it—streaming in. When they looked, they found not the sun, but 18 of the sun's able little imitators—General Electric floodlights. They had been mounted on the ninth-floor level.

The engineers were thoughtful of the tenants' feelings. For when the switch is thrown no sudden glare of light paralyzes unaccustomed householders in the act of brushing their teeth or doing setting up exercises, pastimes which were formerly cloaked in intimate gloom. A fully automatic synchronous-motor time switch actuates a dimmer, and the floodlights do not attain full brilliancy for 15 minutes.



GROANING RAILS

A FEW weeks ago, the rails between Schenectady and Benning, D. C., groaned under what is believed to be the heaviest load ever transported on a single car. The load consisted of the generator shaft, rotor, and poles for a General Electric frequency-converter set being installed at the plant of the Potomac Electric Light and Power Company to deliver 25-cycle, single-phase power to the Pennsylvania Railroad.

Because of weight and clearance requirements, however, the route of the shipment was round about. A check of practically every foot of the way was made to determine if temporary obstructions could be removed to allow the load to pass. From Schenectady to Wilkes-Barre, Pa., the car traveled on the Delaware & Hudson. From Wilkes-Barre, the car was sent to Hagerstown, Md., on the Pennsylvania Railroad, where it was turned over to the Western Maryland Railroad. After an extensive detour, it was delivered back to the Pennsylvania on its main line just south of the Baltimore tunnels, which were the principal reasons for the complicated routing. From there it was carried directly to the power company's siding in the District of Columbia.

The equipment weighed 367,000 pounds. The special car added another 104,300 pounds, making the total weight on the rails 471,300 pounds.

FISH LIFE SAVER

THE people in the New York Aquarium were very unhappy. Many of their rare fish were dying of a mysterious malady. An investigation showed that the water pumped into the tanks contained contaminating metal salts, and that these salts came from the metal pumps in the system.

They appealed to the H. A. Smith Pump & Motor Company for help. Mr. Smith began testing all the nonmetallic substances available for making pumps. He tried 14 materials and found that General Electric Textolite was the only one that would prevent this pollution of the water and at the same time make a satisfactory pump.

Engineers of the General Electric Plastics Department were called in, and a new pump was designed, using five different grades of Textolite. The pump was so constructed that no water can come into contact with metal.

96-149DH

GENERAL ELECTRIC

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(Cut Courtesy Duke Power Company)

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THE COVER.

The Riverbend Power Plant was constructed by the Duke Power Company on the Catawba River near Mount Holly, N. C. The ultimate capacity of the plant is 450,000 kw., with an initial installation of 137,000 kva. The transformers, 13,200/100,000 volts, are arranged for operation at 154,000 volts when load conditions make the change advisable. The plant is located between the narrow necks of a deep horseshoe bend in the river, and it is thus provided with a large reservoir for cooling water when river flow is not sufficient to supply the ultimate requirement of more than 500,000 gallons of condensing water per minute.

GIMGHOUL CASTLE

Commanding a beautiful view from its eminent position at Piney Prospect, the Castle is considered one of the showplaces of Chapel Hill. It was built in 1926 of native stone and modeled after an English medieval castle. The masonry work is of open-joint construction, which does not show the mortar, and was constructed by Waldesian masons from Valdese, N. C.

THE CAROLINA ENGINEER

VOLUME III MAY, 1935 NUMBER 4

The Bonneville Project

By ROBERT P. HOWELL, JR.

The Bonneville Project consists of the construction of a dam, together with power house, navigation lock, and fishways, across the Columbia River from Oregon to Washington at the head of tidewater. It is 143 miles from the mouth of the river and 42 miles east of Portland, Oregon. Primarily, the purpose of the project is the production of hydro-electric power. Benefits to navigation, although not entirely incidental, are of much less importance.

Salient Facts About the Columbia River And Basin

For a true conception of the project, it should be understood that the Bonneville Dam is but a part, and one of the first steps, in the development of the Columbia River and its basin. As it seems possible that in general Carolina students are not aware of the tremendous potentialities of this region, a few of the facts necessary for a background of this knowledge will be given here.

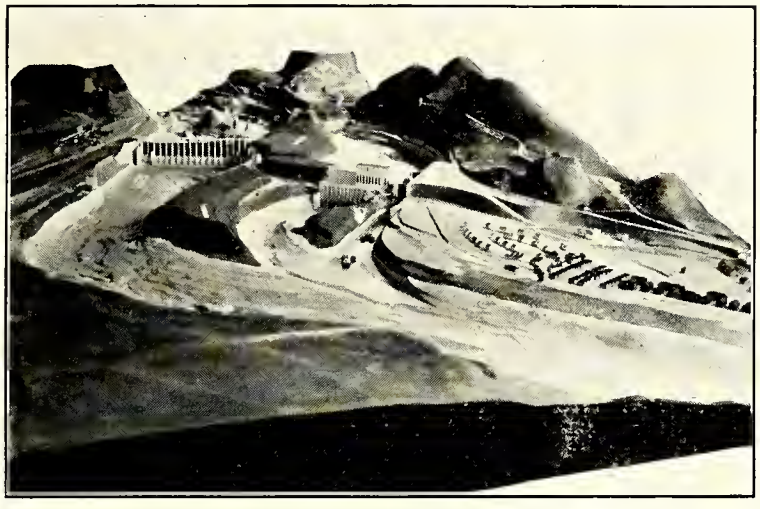


Photo courtesy U. S. Engineer Office.

The Columbia River is about 1210 miles long, of which the upper 465 miles lies wholly in Canada. Of the 745 miles in the United States, 143 miles is tidal; most of the remaining 600 miles in the non-tidal section is suitable for power development. The river drains an area of about 259,000 square miles, including about 39,000 square miles in Canada, between the Cascade and Rocky Mountain ranges. The run-off causes a flow which, at Bonneville, has varied from 43,000 to 1,170,000 second feet (this in 1894), the mean being taken as 200,000 second feet. In the past, this flow has been equaled or exceeded five months of the year. At the international boundary, the normal low-water elevation is about 1300 feet above mean sea level. It is this drop of, approximately, 1300 feet in 600 miles, which engineers hope to use for the production of electric power.

Fully developed, the Columbia will produce 41 billion kilowatt-hours per year, or 4.7 million average kilowatts, of prime power. In the United States as a whole in 1930, total production of utilities and of plants operated by manufacturers was estimated at 125 billion kilowatt-hours.* Thus the Columbia can produce prime power equal to one-third of this amount, and can in addition supply secondary power sufficient for the needs of irrigation pumping. This completed development will utilize about 1200 feet of head, or 92 per cent of the fall between the Canadian boundary and the Pacific Ocean. Depending upon their locations, from eight to ten dams will be required.

Although not affected by the Bonneville Project, the plans for the irrigation of vast areas of cultivatable land in the "Inland Empire" between the Cascades and the Rockies form an important part of the completed development. An area of land totalling nearly two million acres, with rainfall sufficient only for wheat and grass, and for wheat only by dry-farming in certain areas, is irrigable by pumping from the Columbia River. With dams of sufficient storage capacity, secondary power can be used for pumping. Under the comprehensive plan, the structure to furnish the greatest benefit to irrigation will be the much-disputed "high dam" at Grand Coulee, Washington. At present, the U. S. Reclamation Service is in charge of the construction of a dam at Coulee too low for irrigation storage and pumping, but suitable for enlargement at a later time.

Navigation on the Columbia above tidewater has been sporadic, and the tonnage small, although in the tidal section below Vancouver, Washington, 105 miles from the mouth, seagoing tonnage is steadily increasing. Between Vancouver and the

*Columbia River and Minor Tributaries, p.69.

mouth of the Columbia's longest tributary, the Snake, is a 220-mile stretch navigable by stern-wheel vessels. Two series of rapids, at the Cascades and between The Dalles and Celilo, have been by-passed by locks and lateral canals.

History of the Bonneville Project

In the past, many dam sites on the Columbia have been investigated by government and private interests. The most comprehensive study was made by the U. S. Engineer Department, the Seattle and Portland District Engineers collaborating, at the direction of Congress. The report was submitted to Congress through the Secretary of War in 1931 and printed as House Document 103, 73rd Congress, 1st Session, vols. 1 and 2. Most of the foregoing data concerning the river and its basin have been taken from these two volumes. The 1800 pages of this report contain a wealth of material unavailable in published form elsewhere, and can be studied with profit by anyone interested in the power, reclamation, and industrial potentialities of the Columbia River basin.

Construction of a dam at the Bonneville site was authorized in September, 1933, and Secretary Ickes, PWA administrator, allotted $20,250,000 for immediate work. The total cost of the project was estimated originally at $31,000,000.

The project is under the direction of the Corps of Engineers, U. S. Army, through the Portland, Oregon, District. Design of the structures is by civilian engineers, with engineer officers in administrative and executive capacities. Construction is by contract, of which there are at present seven in effect.

The Site

The selection near the head of tidewater of a site with a suitable foundation was a difficult problem. At Bonneville, the river is divided at the higher stages by Bradford Island, a gravel deposit. Across the channel, from the island to the Washington shore, will be the spillway dam, to rest on a tuffaceous rock known locally as Eagle Creek formation. The navigation lock and the power house will be between the Oregon shore and the island, across Bradford Slough, which will act as forebay and tailrace. For both structures, the foundation is a sill of andesite.

The Spillway Dam

The main dam is to be a mass concrete gravity-type structure approximately 1250 ft. long, 180 ft. thick at the base, and of a total height of 170 ft. above the lowest foundation. Above the base block will rise piers and abutment walls in which will be set 18 steel lift-type spillway gates, each 50 by 50 ft., giving a spillway crest 900 ft. long. The normal pool elevation will be 72, and depending upon the stage of the river, the available head will normally range from 40 to 65 ft. A maximum discharge capacity of 1,600,000 second-feet has been provided for—a flood estimated to occur once in 10,000 years. With a flood of this volume the pool elevation will be 82.5, but because of the high tailwater the available head will be small.

The task of cofferdamming and diverting the flow of the Columbia is perhaps the largest of its kind ever attempted. Because of the summer floods, the working season is limited to the eight months of August to March, inclusive. According to the plan for construction, the south half of the channel will be enclosed by a ring of crib cofferdams "tailor-made" to fit the contour of the river bottom, and sunk in place. On the channel side will be driven interlocking steel sheet piling. This area will be unwatered, and the south half of the dam, but with the sills between piers left at elevation -5, will be constructed. The cofferdam will then be removed, and in the next low-water period the north cofferdam will be placed and that half of the dam built. During the past low-water season, the south cofferdam was constructed and unwatered, and some material excavated. With the flood approaching, the water was allowed to rise in the area, and by the time this article is in print the river will be flowing over the cofferdam. Late in the summer, the river stage will be low enough for work on the foundations of the dam to proceed again.

During the construction of the north half of the dam, the flow of the river at low water will be diverted through the base of the power house in Bradford Slough and through the south half of the main dam across the low sills. After completion of the structure the sills will be brought up to full height (24) by means of permanent gates concreted inside of temporary cofferdams.

An interesting sidelight on the cofferdams is the fact that they have been designed by government engineers, and that the United States is responsible for their stability and for any damage to them after completion and acceptance.

The Power House

It is planned that eventually the power house will contain ten 43,000-kw generating units, of which two are to be installed during the present construction. The station service unit is to be of 2,500-kw capacity. Because the power house acts also as a dam across Bradford Slough, the intakes and skeleton substructures for four additional units will be constructed under the contract now in effect. At the north end of the power house there is being constructed a cantilever wing wall of reinforced concrete which, with the backfill behind it, will serve as a cofferdam for future extension of the power house. The

wall is in line with one of the power house piers, and for this reason can be left in place after the additional units have been installed.

The turbines selected are of the Kaplan propellor type, with blades automatically adjustable. Outstanding characteristics of this type are its high efficiency at part load and its flat efficiency-load curve over wide ranges of head and load.

The Navigation Lock

The plans originally agreed upon called for a

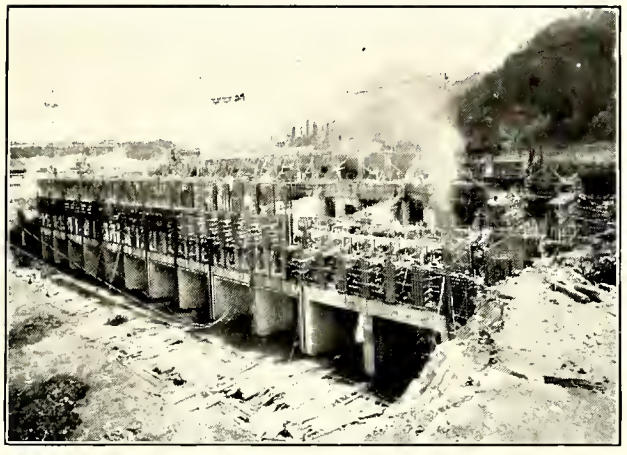


Photo courtesy U. S. Engineer Office.
POWER HOUSE SUBSTRUCTURE

single-lift barge lock, to be modified into double-lift ship locks at some future date. Announcement of a change in these plans was made at Bonneville on a memorable August day last year by the President of the United States. Citing the example set in the past by men of vision, Mr. Roosevelt stated that in his mind the ultimate saving in construction costs warranted making the Bonneville lock large enough for ships at the present time. The lock now under construction will have a lift of 66 ft. at low water (the highest yet built) and of 50 ft. at normal flow. In clear length and width it will be 500 by 76 ft.

The Fishways

Of extreme importance to the large salmon industry are the provisions made for the migration of the fish. Public hearings have been held at which all interested persons have been given the opportunity to voice their opinions about the types of fishways best suited to Bonneville. The plan adopted calls for a combination of "ladders" and "locks." A ladder will consist of a series of pools 15 ft. wide and 30 or 40 ft. long through which a stream of water will travel. There will be a drop of one foot between each pool, and the fish, attracted by the running water, will swim and jump up the ladder to reach the river behind the dam. Three ladders will be installed. An alternate path will be offered by the fish locks, or as they are colloquially named, "elevators." Fish attracted by a stream of water issuing from these locks will swim along a channel leading to a set of two lift cages operating in alternation, by means of which they will be lifted and ejected at the higher elevation. Collection devices too elaborate to be described here have been designed to direct the fish into the fishways.

Model Studies

No discussion of the project would be complete without mention of the use that has been made of model studies as an aid in the design problems encountered. A 1:100 model of the six-mile stretch of river above and immediately below the site was constructed of concrete. With a flow of water through the model measured by weirs, measurements were made of stream-flow conditions, back-water elevations, stream-bed scour, and other factors. Models of the dam and power house and of various types of cofferdams were made and tested with a stream flow simulating various stages of the river. As a result of these tests, some of which involved measuring the pull exerted by the stream on the models, the engineers are confident that at the flood stage of the river with the cofferdam submerged, the stability of the structure will not be endangered. Models of several types of scroll cases and draft tubes for the turbines were also made and tested, as were portions of various proposed spillway sections.

The Future

Some of the objectives in the development of the Columbia and its basin are similar to those of the Tennessee Valley Authority in the development of the Tennessee Valley. A short time ago, newspapers carried tragic accounts of the dust storms in the Middle West. Men engaged in planning this project believe that in the future thousands of square miles of prairie land will be returned to its former vegetation, the buffalo-grass. The farming population of these areas will migrate to the fertile Columbia River basin, which will be freed by irrigation from the vagaries of weather and rainfall, to till the soil and grow prosperous. Industry will grow in the Northwest, attracted by cheap power and a ready market. Freighters will ply the Columbia carrying products of the basin to the Eastern seaboard and to the markets of the world.

Such is the light in which Bonneville and Coulee and the others, for they are coming, are viewed. Justification for these projects is found not in the concepts of traditional economics, but in the belief that one of the important functions of government is to make available for the masses the blessings that nature has given us. Today, Bonneville helps to keep willing workers from starving. Tomorrow, it will help them to live.

The Theory of Drop-Wise Condensation

By SELBY HARNEY

Any person that has observed the formation of mist on a mirror knows that water may condense in small droplets on a cold surface. The organic chemist has seen a clear, though sometimes

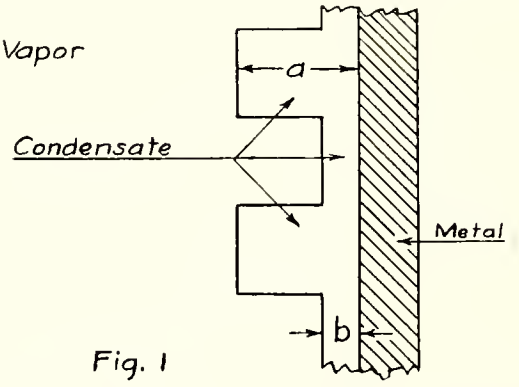


Fig. 1

rippled, film of condensate wetting the interior of a clean condenser tube; and when condensation occurs in an imperfectly cleaned tube, he has observed dry areas wherein drops form, coalesce and slide into irregular rivulets down the tube. This phenomena is not new. Nevertheless, its full significance was not appreciated until 1930 when Schmidt, Schurig and Sellschopp published the results of their brilliant researches which showed that there were marked differences between the heat transfer coefficients of the two modes of condensation — drop-wise and film-wise.

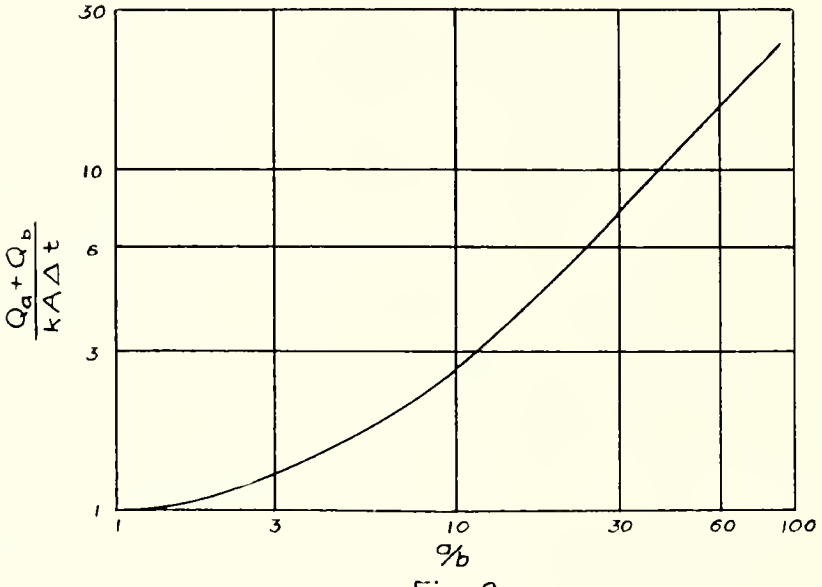


Fig. 2

They studied the condensation of steam on a vertical water-cooled wall, and photographs were taken of the condensate side of the wall. According to the condition of the plate, one or two forms of condensation was observed. On a rusty or etched plate, the steam condensed in a continuous film over the entire surface of the plate. While with a polished plate of chromium-plated copper, the condensate formed in drops which grew rapidly in size and ran down the plate. Drop-wise condensation was also brought about for a while by coating the plate with a thin petroleum oil which ultimately washed away. Drop-wise condensation gave heat transfer coefficients four to eight times as high as the coefficients for film condensation. In their summary, Schmidt, Schurig and Sellschopp held that steam condensed in the form of a continuous film on "dirty surfaces or surfaces roughened by etching," and condensed in the form of drops on "clean and smooth surfaces."

In most of the original papers dealing with drop-wise condensation no explanation has been given for the fact that the mode of condensation has an individual coefficient of heat transfer that is much higher than that for the film type of condensation. Such an explanation is found in the method of reasoning used by Ginabat in 1924 and summarized by Wulfinghoff in 1933.

Suppose that a layer of condensate forms on a cooling surface in the form diagramatically shown in Fig. 1, and let one of the two adjacent spots of equal area, A, be covered by a thickness, a, and the other be covered by a thickness of condensate, b. Let Qa be the heat current through the layer of thickness, a, and Qb be the heat current through the layer of thickness, b.

If the temperatures of the steam and the cooling surface are substantially uniform, we may write,

$Qa = KA\Delta t/a$ and

$Qb = KA\Delta t/b$

where K is the thermal conductivity of the condensate and Δt is the temperature drop from the condensate to the cooling surface. *(Continued on page thirteen)*

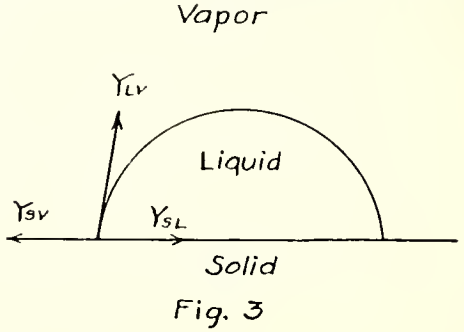


Fig. 3

Highway Planning for Greater Safety

By Prof. T. F. Hickerson

During 1934, 36,000 persons were killed and 954,000 injured from automobile accidents on the streets and highways of the United States. In North Carolina alone, 986 fatalities occurred.

In classifying highway and street accidents, there are mainly three general types of contributing factors, as follows:

(1) Incidental to the drivers themselves; such as reckless speeding, general disregard for or ignorance of traffic regulations, drunkenness, bad vision, drowsiness, inattention, over-strain, and general incompetence resulting from no standard licensing law.

(2) Incidental to the motor vehicles; such as bad brakes, defective steering gear, bad headlights, broken parts, etc.

(3) Incidental to the location, design construction or maintenance of the highways or streets; such as exposure to intersecting traffic, sharp curves with insufficient super-elevation, steep grades, high crowns, slippery surfaces, narrow pavements, treacherous shoulders, steep ditch slopes, narrow bridges, holes in the surface, etc.

Conditions contributing to the third class of accidents are primarily the engineer's problem. Although statistics show that the larger proportion of motor vehicle fatalities are attributed to reckless speeding, it is none the less of an obligation for the engineer to aim to effect every reasonable feature of design that promotes the greatest possible comfort, speed and safety for all those who use the highway.

So long as motor vehicles are being manufactured with greater speed capacities and in greater quantities for both passenger and freight transportation, the highway engineer will be expected to keep pace with these developments and, within the limits set by the funds at his disposal, he must not only design and construct highways sufficiently spacious to accommodate present traffic and its normal future increase without undue traffic delay, but he must also safeguard them against every hazard that high-powered, high-speed motor vehicles can create in the hands of incompetent or reckless drivers.

Highway Intersections

At an ordinary cross-road, there are 12 possible courses open to traffic—four right and four left turns that may be made, besides four ways to go straight. Each, except the right turns, cuts across four other possible paths. Occasional collisions under such circumstances are inevitable, especially at the high speeds of rural travel.

The traffic signal and the stop sign, when perfectly obeyed, achieve an orderly movement of vehicles and a notable reduction in hazard; but neither solves the left-turn problem with its possibilities of almost head-on collisions. Ample vision ahead and advance warning or stop signs of a standard type are necessary safeguards at rural intersections. Billboards and other non-official signs should not be allowed within the vicinity of a cross-road; and it seems desirable that all roadside advertising should be regulated by law, as is done in the State of California.

The majority of highway intersections, even in congested areas, will probably remain at grade; and their treatment for minimizing the hazard is deserving of much study.

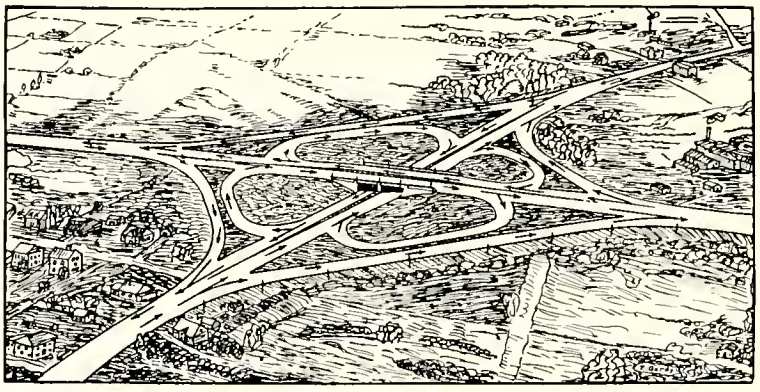
If traffic circles or similar grade structures are used, it is fundamental that the driver be informed in advance of their presence and of the proper course to be pursued. This means that the islands must be adequately lighted or signed.

Many special types of highway grade separation designs with various arrangements of ramps and underpasses have been built in New Jersey to accommodate traffic conditions occurring in congested areas. But the so-called "clover-leaf design" (Fig. 1) has the advantage that there are no lanes of traffic which cross each other and that there is no slowing up of the straight traffic. The complete clover-leaf design has a ramp in each quadrant so that when left turns are made in spiral fashion—that is, by crossing over or under the intersecting road and then making two successive right turns—no vehicle need ever cross the path of another, and the only possibility of collision arises when a vehicle turns to the right into a through traffic lane, a minor hazard, especially on multi-laned roads.

The minor intersections of local or private roads or driveways with through highways are a constant source of danger because they are so numerous and, frequently, so obscure. Expensive treatment of each individually by traffic signals or re-design cannot be justified, and stop signs too often fail in their purpose because of non-observance by drivers.

Accordingly, the concept of the *freeway* proposed by E. W. James, of the Bureau of Public Roads, has been developed—a highway for express traffic to which abutting property has no right of access. All local traffic must use service roads in the vicinity, and traffic may enter or leave the freeway only at widely spaced intersections where it can be properly safeguarded. Under this plan, a new express highway remains an express highway instead of becoming just another suburban or urban road.

Few areas can now produce enough traffic to justify the most expensive type of construction, but even the less important highways may have some of its features, and the probability of future development should always be considered in present planning.



Railroad Insections

The problem of railroad-highway crossings is similar to that of highway intersections, in that only a separation of grades can make safety sure, especially with the development of the new high-speed trains. There is a growing sentiment in favor of closing many existing crossings and providing more adequate protection, or grade separation, at the others, on the theory that modern motor-vehicle traffic can well afford the slight expense and inconvenience of detouring a mile or more for the advantage of greater protection. For protection of the remaining crossings where grade separation is not practicable, the standard flashing lights of wigwag signals, put into operation by approaching trains, are becoming more general on the rural highways.

It has been estimated by Mr. Ford of the Rock Island Lines, that there are now 235,800 highway-railway grade crossings in the United States, of which 30,000 should be separated, 100,000 need protection, 45,800 require but minor attention, and 60,000 might be closed by relocation or some form of proper planning.

Separated Roadways

Considering the number of vehicles which pass each other in opposite directions on the open road, the statistical chance of any two colliding is infinitesimally small. In the aggregate, however, head-on collisions make up a very serious part of the total, and among the earliest of highway improvements was the widening of the pavements to increase passing clearances. Demands for greater traffic capacity have been met by widening to three lanes, four lanes and more, but vehicles using the center lane or lanes must still pass close to opposing cars and, in addition, face the added danger of being crowded by cars on their right.

The painted center line, which is now almost universal on curves and on hills, especially where sight distance is impaired, is effective and popular, but it cannot prevent the careless motorist from crossing over to the wrong side at times, with possible serious consequences.

To keep opposing cars safely apart, it is clear that there must be some physical barrier between them. The *safest and most ideal highway* must be built with two separate roadways, each for traffic in one direction only. Each must be at least two lanes in width to accommodate fast and slow traffic in different lanes. But until vastly greater highway funds are available, this design will probably be limited to highways on which the volume of traffic justifies the expense of four-lane construction.

Sight Distance

As an element of safety, ample sight distance or visibility is desirable so that every condition of the highway, whether an intersection, a curve, or anything that requires the driver's attention, should be seen far enough ahead to enable him to take appropriate action. In the design of both horizontal and vertical curves, sight distance should be a controlling factor. A minimum sight distance of 800 ft. is recommended for two-lane trunk highways.

Alignment

With the advent of fast-moving, high-powered motor vehicles, improvements in alignment are increasingly desirable, not only as an element of economy in reducing distance, but as an element of safety against accidents. The alignment should be made as safe as possible considering the funds available, even at the expense of a steeper grade (up to a reasonable maximum). Short curves and abrupt turns are particularly hazardous on steep grades, at the foot of long hills, and between long tangents.

If reverse curves are necessary they should be separated by a tangent distance of at least 200 feet, thus allowing space for runoff casements on each curve.

Hidden reverse curvature or a combination of

horizontal curve with a summit vertical curve is an unsafe combination, and should be avoided.

Curves in the same direction with a short tangent between them, commonly known as broken-back curves are objectionable from the standpoint of appearance, and they may be a source of danger.

An unexpected change from one standard of alignment to a lower standard, as, for example, a few isolated sharp curves within a zone of good alignment or an unexpected reversed curve at the end of a long tangent, is a source of danger and is responsible for many accidents. Whenever such special conditions unexpectedly reduce the vision of motorists at isolated locations, much time and money should be given to eliminate or improve them, particularly on main routes. If the elimination of these hazards is impossible, as in mountainous country, then unmistakable warning signs should be on display far enough away for the motorist to gradually reduce his speed limit.

To avoid the appearance of a kink in alignment, curves with small angles should not be less than 300 feet in length. All horizontal curves are greatly improved in appearance and in comfort and safety as well, when connected to tangents with long transition spirals which should apply both to the outer and inner edge of roadway; and curves sharper than 1 to 2° should be superelevated. Pavements on curves sharper than 7° should be widened.

Properly spiraled and superelevated curves of 1000-ft. radius can be comfortably negotiated by an automobile at speeds up to 55 to 60 miles per hour.

Unfortunately for the motorist, there are altogether too many curves on which the surfaces are flat or even worse, have negative banking—that is, sloping downward toward the outside of the curve. This creates a tendency to encroach on the wrong side of the road by making a left turn on the inside of the curve. Proper superelevating and spiraling and the painted middle strip will help remedy this condition.

Grades

From the standpoint of ascent, the modern high-powered car can climb readily short grades as steep as 8 per cent; but even so, continuous grades of more than 5 to 6 per cent are objectionable on trunk highways. To descend grades steeper than 7 per cent may at times subject the motorist to great hazards, particularly when the road surface is coated with ice.

An effort should be made to obtain the least possible grade consistent with a reasonable expenditure of funds. By the use of lower maximum grades, more uniform speed of car operation can be maintained and greater reserve power will be available for retarding and accelerating when passing slow vehicles in emergency.

Rolling grades may be justified by construction economy, and they often present no appreciable economic loss in operation. Their objectionable feature lies in hazards as vertical curves and in roadway appearance. For this reason, grade rates should be held to a minimum and vertical curves should have a long sight distance.

Shoulders and Roadside Safeguards

To keep the traveled lanes safely clear of stopped vehicles, every highway must be designed with *shoulders* that are wide, smooth and substantial enough to serve as an emergency traffic lane. Generous shoulders clear of all obstructions and gentle ditch slopes will often make a minor accident out of what otherwise would be very serious.

Guide and guard rails serve a two-fold purpose: (1) as valuable safeguards for warning motorists of the existence of curves, embankments, side hills, or other hazardous conditions; and (2) to prevent a vehicle from leaving the pavement and shoulders of the highway.

Separate pathways for pedestrians should be constructed on one or both sides of the main highways. Underpasses for pedestrians are advisable in congested school zones.

Widths of Pavement and Bridges

The American Association of State Highway Officials recommends for safety at least 10 feet of width for each traffic lane of the highway, and a shoulder width of 10 feet.

Irregularities in alignment and grade are more definitely localized and noticeable at bridges than elsewhere. The effect is made more acute by the fact that most bridges are narrower than the roadbed, and therefore dangerously narrow. Good practice as to the width of bridges is to use multiples of traffic lanes 10 feet wide plus 2 feet on each side.

The Driver and the Vehicle

The fitness of the driver and the condition of the vehicle, particularly as to brakes and steering gear, are vitally important phases of traffic safety; both of which present problems more perplexing than the condition of the highway itself.

A measure of control of the few drivers prone to be reckless on the highway may be expected from policing and from licensing laws; and good results should come from educational programs aimed to create a greater sense of responsibility among all those who use the highway. Instead of establishing maximum speed limits, it seems best to adopt the basic code rule that "No person shall drive a vehicle on a highway at a speed greater than is reasonable or prudent under the conditions then existing."

ALUMNI NOTES

Another one of Carolina's prominent engineering alumni who have been called into government service is Mr. Brent S. Drane, a member of the class of 1902. Mr. Drane entered here in 1898 after finishing the Horner Preparatory School in Oxford, N. C. Although he was an engineering student, practically the only course that he could take that was strictly an engineering course was one in surveying taught by Dr. Archibald Henderson. While he was here, he distinguished himself as a scholar, being a member of Phi Beta Kappa. He was also editor of the *Yackety-Yack* during his last year.

Upon finishing here, Mr. Drane practiced civil engineering for two years, and then went to New Mexico, continuing engineering work there mainly in the irrigation field. About two years later, he entered into government service as an engineer; he was sent to Porto Rico where his work consisted largely in developing irrigation projects. Upon returning to North Carolina about eight years later, Mr. Drane opened his engineering office in Charlotte. He continued in private practice until America entered the World War; at this time Mr. Drane again entered into government service. He worked as an engineer with a nitrate plant located in Toledo, Ohio. In 1919 he returned to Charlotte to take up his private practice again. For two years 1924-25 he was State Geologist and was head of the North Carolina Geological Survey. After this work, he returned to Charlotte to continue his practice as a consulting engineer. His practice consisted mainly of quarrying operations and highway construction. He worked over a rather large territory consisting of practically all of the coast line states. About a year and a half ago he was called to Washington to work as a PWA engineer in the Department of Interior. This work consists mainly in checking plans which are submitted to the department. He is still connected with the government in this capacity.

Jason Glace, a former member of the present civil graduating class and a star basketball center, is working as an assistant to an architect in his home town, Harrisburg, Pa. He was down the other week-end for the Junior-Senior dances. Jason says that he is going to an architectural school next year.

The other day we had a letter from John Geiger, a civil graduate in the class of '33. At the present he is cost engineer with the National Furniture Company located in Mount Airy, N. C. He says that this is a step toward becoming an Industrial Engineer which he is particularly interested in being. John will be remembered as one of the engineers who was a member of both Phi Beta Kappa and Tau Beta Pi; he also helped in getting THE CAROLINA ENGINEER started. We were very glad to hear from him and wish that more of the Engineering alumni would write back and let us know what they are doing.

N. C. Cameron, another civil and a member of last year's class, is now with Carolina Light and Power Company in Raleigh.

G. G. Thomas, an engineer from the class of 1904, has been with the Atlantic Coast Line Railroad since 1909. He is now Engineer of Metal Structures; he is in charge of construction and maintenance of all bridges and buildings of the whole Coast Line System.

Marion F. Hetherington, a civil graduate in the class of '25, is now with the Federal Power Commission in Washington, D. C. He was formerly with the Southern Railroad. He will be remembered as a member of both Tau Beta Pi and Phi Beta Kappa.

Albert J. Baracket, who dropped out of school two years ago after finishing his sophomore year, is now connected with the test department of the Radio Corporation of America at Camden, N. J.

Robert P. Howell, Jr., who took his first two years here and then finished up at the University of Washington, is now an inspector on the Bonneville Dam project in Oregon. He graduated in 1934 in M.E. with magna cum laude and as a member of Tau Beta Pi and an Associate member of Sigma Xi.

The Advantages of Electric Drive

By J. B. CARNE

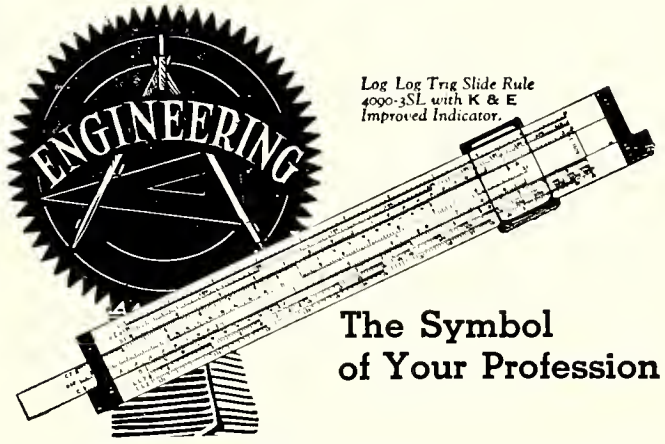
The potential power of all the gasoline engines in America is over ten times as great as the potential power of all the steam locomotives. This means that for every horsepower utilized by the railroads in steam transportation, ten horsepower of gasoline engine energy is utilized in direct competition with the railroads. For obvious reasons, the railroads cannot greatly lower the competition from passenger automobiles, but they can, because of certain inherent advantages, successfully compete with the tremendous freight truck competition. To do this, the railroads have turned to the Diesel engine, a source of power which has been known to them for over thirty years. During the war and immediately after, the high prices of oil prevented the serious development of the Diesel engine for railroad use, but recently these disadvantages have been removed, and the railroads are rapidly developing the field of Diesel-powered rail transportation.

There are two important means of transmitting the power from a Diesel engine to the wheels of the locomotive, the geared mechanical drive, and the electric drive. The first type of drive is exactly the same as is used in automobiles, with a clutch and a transmission between the engine and the wheels. The electric drive consists of a generator, coupled directly to the Diesel engine, which supplies power to electric motors on the axles of the locomotive. Speed control in the geared drive is by means of the clutch and gears, and a throttle on the engine; in the electric drive, by means of a controller in the line between the generator and the wheel motors.

The important advantages of the electric drive in Diesel locomotives are: (1) smoother starting, (2) easier control, and (3) greater efficiency in starting. The first of these advantages is clearly illustrated by a comparison of the starting of an automobile to the starting of an electric motor. Whereas the automobile starts with a series of power pulsations as the gears are shifted, the electric motor comes up to speed gradually and with an uninterrupted surge of power. Furthermore, tests on geared and electric drives in Diesel locomotives have shown that the efficiency of starting a Diesel-electric locomotive is greater than the efficiency of starting a geared locomotive, even though there is a loss in the power transmission of the electric drive. This advantage is due to the fact that the power must be completely shut off from the wheels every time the gears are shifted in a geared drive. This forces the engine to run at slow, inefficient speeds while the locomotive is gaining speed and cuts down the average efficiency of the start. On the other hand, there is no need for throttling the engine during a start when the Diesel electric drive is used. Instead, the engine may be allowed to run at its most efficient speed, and a steadily increasing power applied at the wheels by varying the current through the wheel motors. Of course, after the locomotive finally reaches full speed, the mechanical drive furnishes a slightly larger horsepower at the wheels than the electric drive does, but the advantage of the smoother start more than offsets this slight advantage of the mechanical drive.

In addition to the advantage of smooth and efficient starting, the Diesel-electric locomotive is much easier to control that a Diesel-geared locomotive. In a geared-drive locomotive, the operator has the same control features as are present in an automobile, with a clutch and gear-shifting lever in addition to the throttle and other controls. The electric-drive control is all incorporated into one controller with a single handle.

With these advantages, it is only natural that the electric drive should replace the mechanical drive in Diesel powered locomotives. This the railroads have begun to realize; so that practically all of the new Diesel locomotives, particularly those for passenger traffic, have the electric drive.



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Engineers of the Future

By Wm. J. Miller

Engineering is a peculiar profession. It is as old as history and yet today there are few people who can give a satisfactory definition of the engineer. There are several reasons for this state of affairs. One is that the nature of the field of engineering requires the engineer to work with corporations, governmental bodies and similar groups, rather than with individuals as clients. Thus the individuals of society rarely deal with the engineer in connection with his professional activities. Another is that the profession of engineering rests upon a large and diversified body of artisans which carries out the designs and plans of the engineer. There is not a very definite line of demarkation between the fields of the engineer and of the artisan and sometimes there is an overlapping of the two fields. This accounts for the fact that the layman frequently mistakes the activities of the surveyor, the mechanic, the electrician, and others, for those of the engineer.

In contrast to the engineering profession, the professions of law and medicine are more clearly comprehended by the individuals of society. In general the members of these professions deal with individuals as clients and, therefore, their duties and responsibilities are usually well known. Furthermore, a professional organization in each of these fields governs the admission of new members to the profession. Until the present there has been no such agency among the members of the engineering profession. There has been a recognized need for such an organization, but heretofore the difficulty of bringing about an agreement among the various divisions of the profession appeared insuperable.

Of great importance to engineering students now in school are the present activities of the Engineer's Council for Professional Development, commonly designated as E.C.P.D. In the two and one-half years of its existence, the E.C.P.D. has formulated a rather definite program to accomplish its purpose. This program has four main divisions as follows:

1. The selection and guidance of prospective engineering students.
2. The accrediting of engineering schools.
3. The professional training and development of engineering graduates.
4. The admission of new members to the profession.

To carry out the first objective the Committee has already selected a pamphlet, describing the engineering profession, for distribution to interested students in secondary schools. It is planned to have members of the profession confer with prospective engineering students to better guide only those who give promise of success into the engineering schools. Also some procedure for selecting boys qualified to take up engineering from among those applying for admission is contemplated.

For admission to the profession the Council has adopted a minimum definition of an engineer which is as follows:

"(a) Graduation from an approved course in engineering of four years or more in an approved School or College; a specific record of an additional four years or more of active practice in engineering work of a character satisfactory to the examining body (the examining body in its discretion, may give credit for graduate study in counting years of active practice), and the successful passing of a written and oral examination, covering technical, economic and cultural subjects, and designed to establish the applicant's ability to be placed in responsible charge of engineering work and to render him a valuable member of society."

To prepare the graduate for admission in this manner to the profession, E.C.P.D. has prepared a comprehensive reading list for his proper development. The general subject classification in this list is as follows: Natural Science, Philosophy, including Religion, Economics and Sociology, Psychology, Business and Industrial Management, Literature, History, Biography and

Travel, and Fine Arts.

Thus in the future entrance to the engineering profession will be restricted to those who come from accredited schools and who have the broad, educational foundation necessary to make a success of the post graduate program of development for meeting the standards of entrance to the profession. By 1938 E.C.P.D. proposes to mark each engineer admitted to the practice of the profession as definitely as are the members of the profession of law and medicine.

THEORY OF DROP-WISE CONDENSATION

(Continued from page six)

We may consider how, with a constant average weight of condensate adhering to a unit area of the cooling surface, the ratio a/b affects the average rate of flow of heat through the condensate layer. For the sake of illustration, let a plus b=4. Then the amount of heat transferred through two adjoining spots when a=b becomes,

$$Qa+Qb=KA\Delta t(1/a+1/b)—$$
$$KA\Delta t(1/2+1/2)=$$
$$KA\Delta t$$

The increase of heat transferred as the ratio a/b changes is given in Fig. 2.

In film condensation, adjacent spots have nearly the same thickness as in the hypothetical case where a=b; but in drop-wise condensation, the thickness of the drop is many times the thickness of the condensate layer between the drops. Hence, the coefficient of heat transfer for drop-wise condensation should be markedly higher than that for film-wise condensation, if the amount of condensate that is retained on the cooling surface is no greater for film-wise condensation than that for drop-wise condensation.

When vapors condense on solid cooling surfaces, the entire area of the cooling surface is undoubtedly covered by the condensate. Whether the condensate draws together as tiny droplets or grows into a uniform film of appreciable thickness should depend to a large extent on the molecular attraction between two liquid molecules and between a liquid and a solid molecule. If the force of cohesion between liquid molecules is sufficiently large and the force of adhesion between liquid and solid molecules is sufficiently small, the liquid will be unstable as a film and should form as drops. The forces acting on a drop of liquid on a flat surface (Fig. 3) may be represented by the interfacial tensions Ysv, Ysl, and Ylv where s, l and v refer to solid, liquid and vapor respectively; thus, the subscripts indicate the interfaces referred to. Then, at equilibrium Ysv=Ysl+Ylv(cos a). If Ysv is larger than Ysl+Ylv(cos a), the drop will tend to spread out to cover a larger area; but if Ysv is smaller than Ysl+Ylv(cos a), the drop will tend to become more spherical and cover a smaller area. It is, therefore, possible to set up a relation of the tendency of film formation; and conversely, it is possible to write the tendency of the formation of a drop; this tendency is measured by Z=Ysl+Ylv—Ysv. Therefore, drop-wise condensation of a vapor should be favored by a high surface tension of the condensate liquid and a high interfacial tension between the solid and the liquid and a low interfacial tension between the solid and the vapor. For example, such liquids as water, mercury, glycerine and aniline which have high surface tensions should have a tendency toward drop-wise condensation, other things being equal.

From the laws of interfacial absorption, it is apparent that it is easy to lower the surface tension of a liquid by the addition of a small amount of a suitable substance; but to increase surface tension by a similar addition is impossible. Hence, if there is no choice of vapor to be condensed, there is little that can be done to increase Ylv. Therefore, from a practical point of view, the problem of varying the type of condensation, which is equivalent to varying the value of Z, reduces to the problem of changing the difference between Ysl and Ysv. This difference is readily altered by surface treatment and contamination.

A clean, fat-free glass surface is completely wettable with water; all fresh, highly polished metal surfaces are found to be completely wettable with water if the powder used in polishing was fat-free. In other words, Ysl—Ysv is very small for water on clean glass or metal surfaces. This complete wettability would lead one to expect film-wise condensation on all clean metal surfaces. In general, this expectation is realized. Such cleanliness, however, is difficult to maintain; if the metal stands in air for a short time, complete wettability may be lost because of contamination by foreign matter or products of corrosion. Probably, it is just such contamination that makes the difficulty of maintaining complete film-wise condensation of clean metal surfaces.

It is well known that greasy surfaces of all sorts are not readily wettable with water. Thus, the difference Ysl—Ysv, and hence Z, for water on the surface of a solid is increased by contaminating the surface with oil. It has been shown that the interfacial tension between metals and fatty oils or acids is less than the interfacial tension between metals and water; that is, fatty oils and fatty acids have a greater tendency to adhere to a metal surface than has water. Consequently, it is found that oleic acid and other fatty materials are very effective for maintaining drop-wise condensation on smooth metal surfaces.

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VOCATIONAL GUIDANCE

High school students considering engineering as a profession should be guided in making their choice, for many students enter engineering schools without a real conception of the profession or of the engineering curricula. Often students go to an engineering school who want to attend a technical or trade school. Others are misled by a desire to play with wonderful exhibits seen at engineers' fairs; still others, by a wish to lead an adventurous life.

Such ignorance of engineering naturally results in many maladjustments in the engineering school and in a high failure rate among freshman engineers. The failing or changing of courses by engineering freshmen, besides being undesirable, is an economic waste. Moreover, such failures and changes have a bad psychological effect upon the student, who sometimes feels that a stigma has been placed upon him. Still, we know that an excellent mechanic may not necessarily make a good or even fair mechanical engineer, or that the boy who may be able to put a radio together blindfolded will develop into an electrical engineer.

This ill-adaptation is not only detrimental to the students themselves but hinders the engineering school program and tends to lower the standards of the engineering profession. The progress of any class is dependent upon its weaker members. Consequently, if the group from the beginning is a select one, much more material can be covered and mastered thoroughly, and the standards of the school can be maintained at a higher level. Better equipped students entering the field of engineering will tend to raise the standards of the profession.

Present students of engineering should advise the high school students back home who are interested in such a vocation by presenting to them facts about engineering education in general. Perhaps a program could be developed by some student engineering society for visiting high schools and explaining facts about the profession.

Whether this suggestion is taken or not, much good can be accomplished by the individual student assuming some responsibility for the guiding of high school boys. To the boy interested in engineering suggest the reading of "Vocational Guidance in Engineering Lines," written by a group of prominent engineers and sponsored by the American Association of Engineers, or of Williams' "Building an Engineering Career."

AFTER GRADUATION

To you who are graduating a charge is made to develop a sense of loyalty to each other. As you spread out into industry, forget any little jealousies and unpleasant encounters that may have occurred during your four years here; be the first to congratulate your former classmates for fruitful attainment and the last to condemn and destructively criticize them.

As you develop into positions of importance, assume a greater responsibility for, and an interest in, the School of Engineering and its alumni and undergraduates. Remember that the men who follow you to this institution look to you for guidance and counsel. Since the development of any school is dependent to a large extent upon the interest and activity of its graduates, become a part of the unorganized Society of Carolina Engineers, seeking to promote the welfare of the School of Engineering, its alumni, and undergraduates.

ACTIVITIES OF THE SOCIETIES

A. S. C. E.

On Thursday, April 11, the local student chapter held its sixth meeting of the school year. The guest speaker was Mr. W. M. Pratt, the society's contact member. Mr. Pratt's talk embraced two topics, the value of engineering training and Durham's new sewage treatment plant. At the conclusion of his speech, plans for the approaching state A.S.C.E. convention were discussed and W. H. McNairy was selected to represent the chapter at the student conference. P. L. Onasch then gave an illustrated lecture on the "Floriannapolis Bridge" at the close of which the meeting was adjourned.

On April 25 and 26, the members of the society attended the annual state convention of the A.S.C.E. in Durham. At the student conference, steps were taken toward a permanent organization. A constitution was drawn up and officers were elected for next year. Mr. J. A. Westbrook, member of the local chapter, was elected Secretary-Treasurer.

On Friday many interesting and educational talks on highways, social planning and aviation were delivered by T. F. Hickerson, R. G. Browning, H. W. Odum, Mr. Myers, and Mr. Olsen.

A. S. M. E.

The local student chapter of the A. S. M. E. has elected the follow men as officers for next year: Honorary chairman, Mr. Colin Carmichael; chairman, Raymond A. Miller; vice chairman, H. E. Robbins; secretary-treasurer, Thomas W. Wilson.

A. I. Ch. E.

The local chapter of the A. I. Ch. E. met on May 9 to discuss the allotment of funds to those members attending the National Student Convention in Philadelphia. It was decided to pay each man eight dollars unless more than six should go. If this should be the case, fifty dollars would be evenly divided among the students going.

Slides picturing the manufacture of aluminum were the feature of the meeting on May 16.

The following men have been elected as officers for next year: Henry Allison, president; William Binder, vice president; Hugh Davis, secretary; Dick Bear, treasurer.

The annual scholarship of $50 given by the local chapter has been awarded to Hugh Davis, sophomore from Winston-Salem.

ALPHA CHI SIGMA

Alpha Chi Sigma gave a banquet on April 29 in honor of A. R. Macormac, D. E. Askew, R. M. Neel, S. B. Knight, and P. M. Nichols, newly initiated members. After dinner the members heard talks by Dr. Dobbins and Dick Huber.

The evening of the Senior Ball the active members and their dates were entertained at supper in Graham Memorial by the very amusing performances of Harry Miller, Walter Bateman and Dick Haynes.

"The Rhosette," publication of the local chapter, will be issued shortly for the first time in several years. Jack Crutchfield has been elected editor.

TAU BETA PI

Tuesday evening, May 7, Tau Beta Pi installed the new officers who will serve next year. The officers installed are as follows: Henry Allison, president; Tom Gordy, vice president; Angus Davis, recording secretary; Bob Neel, corresponding secretary; Ernie Eutsler, treasurer; and Selby Harney, cataloguer. The new officers were honored by a banquet given at the Carolina Inn on Friday the tenth, at which Dr. Archibald Henderson delivered an enjoyable talk.

The chapter had a supper in Graham Memorial on Friday, May 24, at which time Dr. E. R. Groves spoke to the group.

A. I. E. E.

On March 7, following a discussion of the senior inspection trip, the chapter heard the conclusion of Professor Lear's talk on the application of motors to sewage disposal and water distribution. Mr. Lear discussed the induction motor, the wave-wound motor, and the synchronous motor and their application to water distribution and sewage disposal.

Mr. Farrell, senior, followed Mr. Lear with an interesting talk on the construction and operating principles of the induction voltage regulator.

On April 26 the North Carolina Section of the A. I. E. E. met at Chapel Hill. Many interesting talks were presented by students and senior members of the Institute. An informal dinner was attended at the Episcopal Parish House. The program of the day was concluded with an address by Mr. H. A. Affel of the Bell Telephone Laboratories, on "Precise Frequency and Time Over Wires."

Resourcefulness

Listening to the efforts of a student to extricate himself from the strong arm of the law afforded the writer no little amusement. The student, it seems, was driving a DeSoto Airflow at the time of his arrest. He pled not guilty, and was allowed to question the officer who arrested him. Question: "Does not the Airflow, because of its shape, look as though it is going faster than it is really travelling?" Said the officer of the law: "Well, I don't know anything about the mechanism of the car!"

Musician

It is rumored that Editor Walter King is interested in continuing his study of the bassoon since he met a very talented young lady with the same calling from the University of Michigan.

Circles

Great is the power of the harmless looking cigar. B. B. Parker, electrical engineer and driver of one of the cars on the New York inspection trip, discovered this startling fact in a roundabout way. After smoking one cigar, he drove around a traffic circle in Maryland four times and then started back in the direction from which he had come.

Champeen

One night during the Senior Inspection trip to New York, R. M. Query found himself in the company of a number of strange men. However, A. J. Snively saved the day by informing the strangers in a very confidential manner that Query was the wrestling champion of Carolina for his weight class. Thereafter he was treated with great respect and was even allowed to accompany them out to Long Island to a chicken farm. It was rumored that there he showed the owner the proper method of wringing a chicken's neck.

Publications

Southern Engineer is the title of the new publication being released by State College. Commented James A. Westbrook, a civil engineer and railroad bridge designer, "We should change the title of our publication to Atlantic Coast Line."

Bewilderment

"Red" Douglas spent some minutes in deliberation in E. E. Lab. He finally came to the conclusion that the ammeter was no good. It remained for Prof. J. E. Lear to disclose to him the fact that the meter was not connected in the circuit.

Pipes

Jim Westbrook had the disagreeable task of boiling a particularly malodorous solution in sanitary laboratory one day. To partially offset the fumes, he lit his pipe. Prof. "Pop" Hoefer soon walked in, spied the pipe, and then asked Westbrook why he smoked such a dirty pipe.

Watch

A sign in Phillips reads: "Found, a watch. Owner can have same by describing. Watch found in faculty wash room. See J. E. Lear." This tells only part of the story. Since the watch was found, it disappeared for a period of several days, and then just as mysteriously reappeared on the desk of the professor. Wonder why Hagood doesn't claim it?

Nuptials

A certain senior is anxiously awaiting graduation. At that time he plans to announce his marriage which took place a year or so ago, and a secret which he has carefully guarded since it took place.

Consolidation

"Streamline" Wharton, elongated sophomore chemical, has given the best reason for moving the Engineering School to Raleigh that we have heard. "Streamline" wants the school moved to Raleigh so he can quit engineering.

Some Designer

W. H. McNairy, lantern-jawed chisel-chinned spike driver, after eight weeks work on the design of a bridge, has finally discovered the span length of his bridge.

School Boy

When the A.S.C.E. had its picture taken, the photographer, told one of the boys to get on the back row so that the faculty could stand on the front row. Mr. Geyer, sanitary instructor, quietly obeyed.

Walks of Life

Three new members were taken into the Best Walks Club recently. They are Eddie Gaskill, mountain climber, Jack Pruden, six-gator ex-track man, Tom Gordy, tight-rope walker. Note: The editor of this publication and Mr. Winkler are charter members of this organization.

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